

## North Atlantic tropical cyclones of 1940

[Synopsis of tropical cyclones of 1940 (number of storm in table corresponds to number of track on accompanying chart)]

Storm	Date	Place where first reported	Coast lines crossed	Maximum wind velocity reported	Lowest barometer reported	Place of dissipation	Intensity	Remarks
I.....	May 18-27	Southeast of Turks Island.	None.....	Force 8, southeast, M. S. <i>Good Gulf</i> .	995.6 millibars (29.40 inches) M. S. <i>Lubrafof</i> .	Southwest of Newfoundland.	Not of hurricane intensity.	No loss of life nor property damage.
II.....	Aug. 2-10	Off the coast of Georgia.	Florida, Texas....	Force 11, south, S. S. <i>Connecticut</i> , 82 miles northeast at Port Arthur, Tex.	977.7 millibars (28.87 inches) Port Arthur, Tex.	North-central Arkansas.	Probably of hurricane intensity.	1 person drowned, wind and rainfall damage in excess of \$1,743,550.
III.....	Aug. 5-15	Between St. Martin and St. Thomas Islands.	South Carolina....	Force 12, east-southeast, S. S. <i>Maine</i> .	974.7 millibars (28.78 inches) Savannah, Ga.	Southern Virginia.	Full hurricane....	An estimated 50 lives lost and many millions of dollars in crops and property damage due to high winds and floods associated with this hurricane.
IV.....	Aug. 30-Sept. 3.	225 miles off the Florida east coast.	Nova Scotia.....	Force 12, east-southeast, Tanker <i>Franklin K. Lane</i> .	965.1 millibars (28.50 inches) Tanker <i>Franklin K. Lane</i> .	Quebec.....	Full hurricane....	No loss of life, slight property damage.
V.....	Sept. 11-18	Northeast of St. Thomas, V. I.	Newfoundland....	Force 12, north-northeast, S. S. <i>Borinquen</i> .	988.3 millibars (29.19 inches) S. S. <i>Borinquen</i> .	Newfoundland....	do.....	No loss of life nor property damage.
VI.....	Sept. 19-24	Northeast of Bluefields, Nicaragua.	Honduras, Yucatan and Louisiana.	Force 8, southwest, Tanker <i>Dannedaike</i> .	1,004 millibars (29.65 inches) Tanker <i>Dannedaike</i> .	Western Alabama.	Not of hurricane intensity.	Do.
VII.....	Oct. 20-23	A short distance north of the Canal Zone.	Honduras.....	Force 9, northeast, S. S. <i>Contessa</i> .	982.7 millibars (29.02 inches) S. S. <i>Contessa</i> .	South of Puerto Cabezas.	do.....	Considerable property damage on the northern coast of Nicaragua.
VIII.....	Oct. 24-26	Greater Antilles.....	None.....	Force 7, northeast, unidentified ship.	1,008 millibars (29.77 inches). Unidentified ship.	West-central Atlantic Ocean.	do.....	No loss of life nor property damage.

## METEOROLOGICAL AND CLIMATOLOGICAL DATA FOR DECEMBER 1940

[Climate and Crop Weather Division, J. B. KINCER in charge]

## AEROLOGICAL OBSERVATIONS

By EARL C. THOM

The mean surface temperatures were above normal generally over the United States in December (chart 1). A small area in northern New York had temperatures below normal. A large part of the States of Montana and North Dakota and smaller areas in the East Central States had mean monthly temperatures 6° and 7° F. above normal.

At the 1,500-meter level the directions of the 5 a. m. (E. S. T.) resultant winds at most stations were south of normal for the month. The only station at which a considerable opposite turning from normal occurred at this level was Houston, Tex. As will be noted from chart IX none of the pilot-balloon stations along the Pacific coast, in the North Central States or in the East Central States and only one station in the northeastern section had 10 or more 5 a. m. observations during the month at the 3,000-meter level. Over the rest of the United States at this level slightly more than half of the stations had resultant winds from directions somewhat south of normal. Only one of the stations included in table 2 and located in the northern half of the country had 10 or more 5 p. m. observations which reached the 5,000-meter level during December and only 7 such cases were noted to the southward. The shifting of the resultant winds were equally divided at this level, half of the eight stations reporting 5 p. m. resultant winds from directions to the north of the corresponding 5 a. m. normals and the other half from directions south of these normals.

The 5 a. m. resultant velocities for the month were higher than normal at the 1,500-meter level over the extreme West, the Southwest, and over small areas in the North Central and Northeastern States and were lower than normal over the rest of the country. At this level the largest positive departure was at Medford, Oreg.,

where the resultant velocity was 2.9 meters per second above normal while the largest negative departure, 2.5 meters per second below normal, occurred at Houston, Tex. At one-half of the 12 stations, for which comparisons with normals could be made at the 3,000-meter level, the resultant velocities were above normal and at the other half these velocities were below normal. At this level a large negative departure, 5.6 meters per second below normal, was noted at Atlanta, Ga., with an almost equal opposite departure, 5.0 meters per second, above normal at Boston, Mass. At two of the eight stations where the 5 p. m. resultant velocity at 5,000 meters could be compared with the corresponding 5 a. m. normal, the afternoon resultant velocities were lower than the morning normals while at the other stations the afternoon velocities were much higher than these normals. At St. Louis, Mo., the 5 p. m. resultant velocity for the month at 5,000 meters was 12.3 meters per second higher than the corresponding morning normal.

It is noted that the above normal surface temperatures (chart 1) are well supported by the turning of resultant winds to the south of the directions of the normal resultants at the 1,500-meter level.

At the 1,500-meter level the directions of the 5 p. m. resultant winds for the month (table 2) were to the north of the corresponding 5 a. m. directions at most stations in the extreme north, the west central and the south central parts of the country and were generally south of these morning resultant directions over the rest of the country. At 3,000 meters the lack of sufficient observations prevent a similar comparison for stations situated on the Pacific coast and in the northeastern and north-central parts of the United States. Except for southern Atlantic coast stations, the directions of the 5 p. m. resultant winds at all stations in the southern one-third of the country were to the northward of the directions of the corresponding morning winds at this level. At most other stations for which this comparison could be made the

turning of the resultant winds during the day was to the southward.

The 5 p. m. resultant velocities at 1,500 meters were lower than those at 5 a. m. over most of the United States. Resultant velocities higher in the afternoon than in the morning occurred at Spokane and at stations located along the South Pacific coast and in the extreme southwest as well as in parts of the North Central States, the Great Lakes region and East Central States. A decrease in resultant velocity during the day occurred at this level over all other parts of the country. At the 3,000-meter level five stations located in a west central area and two stations at well separated locations to the eastward had resultant velocities in the afternoon lower than in the morning, while the opposite was true at all other stations for which this comparison could be made.

The upper-air data discussed above are based on 5 a. m. observations (charts VIII and IX) as well as on observations made at 5 p. m. (table 2, and charts X and XI).

In the United States proper at the 1,000-meter level the maximum mean pressure for the month, 906 millibars, (table 1) was recorded over both Miami and Pensacola, Fla. At each of the standard levels from 1,500 to 12,000 meters, inclusive, the highest mean monthly pressure occurred over Miami. At 13,000 meters a maximum pressure of 175 millibars occurred over both Brownsville and Miami while at the 14,000-meter level Brownsville and Pensacola both had a pressure of 149 millibars, the maximum for that level. At the next three higher standard levels the maximum mean monthly pressure occurred over Pensacola. At both the 1,000- and 1,500-meter levels the lowest mean pressure for December at stations within the United States was indicated at Spokane, Wash. These pressures at Spokane as well as all pressures for this station shown in table 1, are believed to be lower than the true monthly means for this station since observations were made there only during the latter half of the month when abnormally low pressures prevailed in that area. At all standard levels from 2,000 meters to 17,000 meters, inclusive, the lowest mean pressure for the month was observed over Sault Ste. Marie.

At most standard levels mean pressures observed at Alaskan stations were lower than those recorded in the United States while the mean pressures observed at Swan Island were higher at most levels.

At all stations for which airplane or radiosonde observations were made during the month (table 1) the same or lower mean pressures were recorded in December than in November at all standard levels from 1,000 meters to 10,000 meters, inclusive. The only exception was noted at the 10,000-meter level over Washington, D. C., where a mean pressure of 270 millibars was recorded in December, 1 millibar higher than the corresponding November pressure. Pressures at these levels were considerably lower in December than in November at Ketchikan, Juneau, and along the upper Pacific coast of the United States, the mean pressures at Oakland for these levels averaging 5 millibars lower than in the previous month. At higher standard levels no well-defined tendency was noted when comparing mean pressures for December with those for November.

There was a difference of 29 millibars between the highest and the lowest mean monthly pressures recorded at the 8,000 meter level over stations within the United States proper. This was the largest difference between mean pressure values recorded at any standard level. The steepest pressure gradient for the month was observed at 8,000 meters between Sault Ste. Marie and Joliet where

a change of 1 millibar was recorded for each 38 miles of horizontal distance. Gradients were nearly as steep, however, from north to south over any part of the eastern third of the country, the difference in mean pressures at Sault Ste. Marie and Charleston being 24 millibars, or about 1 millibar for each 42 miles.

At the 1,000-, 2,000-, and 3,000-meter levels mean temperatures in December were lower than in November at most stations on the Atlantic coast and at those in the Southwest, the south central and the west central parts of the country. Mean temperatures were higher than in the previous month at these levels in Alaska and over the extreme northwest and north central parts of the country. Corresponding temperature departures were not well defined at these levels over the remainder of the country. At most standard levels from 5,000 meters to 11,000 meters, stations located in Alaska and in the extreme north central states had mean temperatures higher than those of the previous month. Corresponding tendencies were not well defined at these levels for Seattle, Omaha, or Joliet while at all other United States stations lower mean temperatures than last month were observed at these levels. With few exceptions mean temperatures at levels from 13,000 meters to 19,000 meters were higher than corresponding temperatures for November.

Mean temperatures for December this year were generally higher than those for December of last year over the eastern half of the United States and were generally lower to the westward at the standard levels above the surface up to and including 2,000 meters. The principal exception to this occurred over the Great Lakes where temperatures at these levels were lower than last year, and at Spokane where temperatures were higher than last year. At most of the standard levels from 2,500 meters to 6,000 meters mean temperatures for the month were higher than last year over that part of the eastern half of the country which lies above the Gulf Coast and were lower than last year over the Gulf Coast and over the western half of the country. At higher levels no well defined tendency was observed when the mean temperatures for the month were compared with those of last year.

The mean surface temperature for the month of December as recorded by radiosonde observations (table 1) was  $0^{\circ}$  C. or lower at all stations located in the extreme northeast, the Great Lakes region, the North Central States and the northern Rocky Mountain plateau. At three stations in this area, however, temperature inversions recorded during the month resulted in mean temperatures above freezing for the lower levels above the surface and in a level having a mean temperature of  $0^{\circ}$  C. above the inversion. Over the rest of the United States the altitude at which a mean temperature of  $0^{\circ}$  C. was observed during December varied from 4,000 meters (m. s. l.) over Miami, Fla., to 1,400 meters over Lakehurst, N. J. The level of mean freezing temperature was 2,700 meters or higher at all stations south of  $36^{\circ}$  N. latitude. At two stations (Seattle, Wash., and Washington, D. C.) the level of mean freezing temperature was slightly higher than in November, while at all other stations it was lower than in the previous month.

The extreme minimum temperature for the month recorded by radiosondes in the free air was  $-92.6^{\circ}$  C. ( $-134.5^{\circ}$  F.) observed over Swan Island on December 28 at a height of 17,800 meters (m. s. l.). The lowest temperature recorded over United States was  $-84.5^{\circ}$  C. ( $-120.1^{\circ}$  F.) recorded over Miami, Fla., on December 1, 1940, at 15,000 meters and again on the next day at 16,200 meters. Seven stations in the United States

reported the lowest observed temperature during the month as higher than  $-70^{\circ}\text{C}$ .

Table 3 shows the maximum free-air wind velocities and their directions for various sections of the United States during December as determined by pilot-balloon observations. The highest wind velocity reported for the month was 92.2 meters per second (206 miles per hour) observed over Casper, Wyo., on December 28. This high wind was from the northwest at an elevation of 8,910 meters (about 5.5 miles) above sea level. The maximum winds reported in December this year at all levels were the highest reported in this month during the last 4 years.

Tropopause data for December showing the mean altitude and temperature of the tropopause at various stations are shown in table 4 and on chart XIII.

#### MEAN ISENTROPIC CHART<sup>1</sup>

The monthly chart for December as a whole is typical of the winter season with strong westerlies north of latitude  $35^{\circ}$ , and both sets of isobars tending to run parallel to latitude lines. Normal data for this surface are not available, but the mean moisture content over California appears to be quite high.

December 1940 was characterized by widely different types of weather, as can be seen by a study of the weekly climatological bulletins. It is therefore not surprising that the mean monthly isentropic chart reflects no typical correlation with the weather of the month.

<sup>1</sup> Prepared by A. K. Showalter, Hydrometeorological Section.

TABLE 1.—Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent obtained by airplanes and radiosondes during December 1940

Altitude (meters) m. s. l.	Stations with elevations in meters above sea level																Bismarck, N. Dak. (505 m.)				Brownsville, Tex. (6 m.)				
	Anchorage Alaska (41 m.)				Atlantic Station No. 1 <sup>2</sup> (3 m.)				Atlantic Station No. 2 <sup>4</sup> (3 m.)				Barrow, Alaska (6 m.)				Bethel, Alaska (7 m.)				Bismarck, N. Dak. (505 m.)				
	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	
Surface	31	993	-5.3	85	26	1,019	15.3	74	15	1,017	14.3	81	27	1,011	-20.8	83	17	998	-10.8	88	31	956	-7.2	87	31
500	31	938	-2.9	82	26	960	11.0	78	15	958	10.0	83	27	946	-20.6	87	17	937	-6.2	88	31	959	16.0	83	31
1,000	31	880	-3.3	76	26	904	7.2	82	15	902	6.2	87	27	884	-17.5	82	17	827	-5.9	85	31	904	14.2	75	31
1,500	31	825	-6.0	74	28	851	4.9	79	15	843	3.6	83	27	827	-17.5	79	17	824	-7.6	80	31	843	12.2	70	31
2,000	31	774	-8.9	74	26	800	3.2	70	15	798	2.4	69	27	773	-18.7	78	17	773	-10.7	77	31	791	-3.5	65	31
2,500	31	725	-12.0	73	28	752	1.7	56	14	750	.7	60	27	722	-20.4	76	17	724	-13.9	75	31	743	-5.6	63	31
3,000	31	679	-15.0	70	26	707	-2	50	14	704	-2.1	56	27	675	-22.7	72	17	677	-17.1	73	31	697	-8.3	62	31
4,000	31	594	-21.4	67	25	623	-5.9	46	14	620	-8.2	51	27	588	-28.4	68	17	592	-24.5	71	31	612	-14.2	61	30
5,000	30	518	-28.1	66	24	547	-12.2	46	14	544	-14.6	47	27	510	-34.8	65	17	515	-31.4	63	31	535	-20.6	60	29
6,000	30	450	-35.0	65	23	479	-19.0	48	14	476	-21.8	46	27	442	-41.0	62	18	446	-38.5	57	31	467	-27.7	58	29
7,000	29	389	-42.0	61	21	418	-25.8	50	14	414	-28.9	44	27	381	-47.0	47	18	384	-45.5	55	31	405	-34.6	56	29
8,000	29	335	-48.4	51	19	363	-32.9	51	14	360	-36.1	44	27	326	-52.0	52	16	330	-51.8	50	31	350	-41.9	43	29
9,000	29	287	-53.6	51	17	314	-39.9	51	13	311	-42.5	44	27	279	-55.3	53	15	283	-55.8	51	31	302	-48.6	41	29
10,000	28	246	-55.4	51	16	271	-47.3	51	13	268	-48.0	52	26	239	-56.6	56	15	242	-55.8	51	31	258	-53.5	44	29
11,000	27	210	-54.8	51	17	232	-53.3	51	12	230	-52.4	26	204	-55.3	53	14	207	-53.7	51	31	222	-55.3	48	28	
12,000	27	180	-52.9	51	15	198	-57.6	51	11	196	-55.6	26	174	-54.6	51	13	177	-52.2	51	31	189	-54.0	52	28	
13,000	26	154	-51.7	51	14	169	-60.4	51	10	167	-57.7	24	149	-54.7	51	13	151	-51.5	51	30	162	-54.8	52	25	
14,000	24	132	-51.8	51	12	144	-61.5	51	9	142	-61.8	24	127	-55.2	52	12	130	-51.4	51	28	138	-55.7	51	24	
15,000	21	113	-52.1	51	10	122	-64.5	51	7	120	-64.0	22	109	-55.7	51	8	111	-51.1	51	22	118	-56.7	51	24	
16,000	19	97	-52.4	51	10	104	-66.1	51	6	102	-66.4	19	93	-56.5	51	5	95	-50.1	51	22	101	-57.6	51	22	
17,000	14	83	-52.8	51	10	88	-66.4	51	6	85	-66.6	12	79	-58.1	51	12	86	-59.1	51	21	90	-70.9	51	19	
18,000	9	71	-53.4	51	8	74	-65.8	51	5	72	-66.0	9	67	-59.1	51	5	73	-60.7	51	19	77	-67.4	51	14	
19,000																								65	-64.0

Altitude (meters) m. s. l.	Stations with elevations in meters above sea level																Bismarck, N. Dak. (505 m.)				Brownsville, Tex. (6 m.)				
	Charleston, S. C. (14 m.)				Coco Solo, C. Z. <sup>1</sup> (15 m.)				Denver, Colo. (1,616 m.)				El Paso, Tex. (1,193 m.)				Ely, Nev. (1,908 m.)				Fairbanks, Alaska (153 m.)				
	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	
Surface	31	1,018	9.5	89	23	1,012	26.3	89	31	837	-2.5	78	31	884	7.6	61	31	809	-3.7	76	31	942	-11.4	82	30
500	30	960	11.4	80	23	956	23.7	89	31	903	20.9	79	31	852	9.8	55	31	883	-10.0	80	31	883	-10.0	80	29
1,000	30	905	9.7	75	23	904	20.7	79	31	852	18.0	73	31	750	-4.3	63	31	754	5.0	49	31	751	-1.2	66	31
1,500	30	852	8.0	67	23	852	18.0	73	31	798	1.7	69	31	809	7.4	52	31	800	-1.8	74	31	776	-11.3	75	28
2,000	30	801	6.6	61	23	804	15.8	57	31	798	1.7	69	31	750	-4.3	63	31	754	5.0	49	31	705	-7.5	65	31
2,500	30	754	4.1	60	23	757	13.3	43	31	750	-4.3	63	31	709	2.0	48	31	705	-7.5	65	31	679	-16.4	68	28
3,000	30	708	1.7	52	23	713	10.8	33	31	704	-3.3	60	31	709	2.0	48	31	621	-8.8	57	31	594	-22.8	67	28
4,000	30	625	-2.9	43	20	632	4.4	31	31	619	-9.4	59	31	625	-4.4	45	31	645	-15.4	53	29	518	-29.3	64	28
5,000	31	551	-9.5	43	20	551	-12.2	44	31	544	-15.0	57	31	550	-11.1	44	31	482	-17.7	43	30	476	-22.5	52	27
6,000	31	483	-16.2	44	20	475	-22.8	55	31	482	-17.7	43	30	476	-22.5	52	27	449	-35.9	62	28	463	-27.5	51	26
7,000	31	422	-22.9	44	20	413	-30.1	54	30	421	-25.1	41	30	415	-30.3	51	28	388	-43.0	51	26	333	-49.1	51	26
8,000	31	368	-30.0	44	29	358	-37.8	54	30	366	-33.1	88	30	360	-37.6	61	28	351	-42.3	51	28	285	-53.1	51	28
9,000	31	318	-37.7	44	29	309	-45.7	54	30	317	-40.8	54	30	310	-43.9	51	21	285	-53.1	51	28	302	-48.9	51	28
10,000	31	275	-45.4	44	28	265	-52.2	54	29	273	-47.7	54	29	267	-49.8	54	18	244	-53.7	54	27	259	-54.1	54	27
11,000	31	236	-52.7	44	26	228	-55.6	54	28	234	-53.3	54	2												

TABLE 1.—Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during December 1940—Continued

Altitude (meters) m. s. l.	Stations with elevations in meters above sea level																												
	Joliet, Ill. (178 m.)				Juneau, Alaska (49 m.)				Ketchikan, Alaska (26 m.)				Lakehurst, N. J. <sup>1</sup> (39 m.)				Medford, Oreg. (401 m.)				Miami, Fla. (4 m.)								
	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity					
Surface	31	997	-0.7	80	31	998	2.1	83	21	1,005	3.1	84	30	1,015	1.6	80	31	986	4.7	83	31	1,017	19.6	88	31	998	6.2	85	
500	30	958	-1.6	88	31	944	-2.2	81	21	947	1.9	83	30	959	1.4	78	31	954	4.9	83	31	960	18.1	86	31	960	6.4	83	
1,000	30	900	-8.8	78	30	887	-2.3	82	21	890	-3.3	80	30	901	-7.7	72	31	898	4.7	76	31	906	15.0	81	31	903	5.5	78	
1,500	30	845	-8.8	72	29	832	-4.9	83	21	836	-2.5	73	30	846	-2.2	64	31	844	3.7	66	31	854	11.8	79	31	849	5.1	71	
2,000	30	793	-2.0	67	27	780	-7.3	81	21	785	-5.2	89	30	795	-1.6	59	31	793	1.4	65	31	804	9.9	66	31	798	3.2	65	
2,500	30	745	-3.8	64	24	732	-9.9	78	21	736	-8.2	67	30	746	-3.1	53	31	745	-1.9	60	31	751	5.5	51	31	751	1.2	59	
3,000	30	699	-6.1	64	22	686	-12.8	72	21	690	-11.5	66	30	700	-5.7	62	31	700	-3.2	54	31	712	5.4	48	31	705	-1.2	56	
4,000	30	614	-11.4	58	21	600	-19.2	65	21	604	-18.0	62	29	615	-10.5	49	30	616	-9.3	51	30	630	-2.2	40	31	621	-6.7	52	
5,000	31	539	-17.7	56	20	524	-28.1	60	21	528	-24.7	60	29	539	-16.6	51	30	541	-15.9	49	30	555	-6.0	34	31	546	-12.7	48	
6,000	31	470	-24.6	54	16	455	-33.2	57	21	460	-31.5	57	29	471	-23.6	52	30	472	-23.1	48	30	488	-12.7	33	31	478	-19.5	48	
7,000	31	409	-31.7	54	14	394	-39.9	54	21	396	-37.8	54	29	410	-30.7	53	30	411	-30.1	48	30	427	-19.9	34	31	417	-26.7	47	
8,000	31	354	-39.2	54	14	339	-45.1	51	21	343	-44.3	51	29	356	-37.4	50	30	356	-38.1	47	30	373	-28.8	34	31	362	-34.5	46	
9,000	31	305	-46.6	6	13	292	-47.7	57	20	295	-50.1	57	29	307	-44.3	52	28	307	-45.7	52	30	324	-34.4	34	31	313	-42.7	33	
10,000	29	262	-53.4	13	13	250	-48.6	50	20	253	-53.4	50	26	264	-50.1	52	28	264	-52.2	52	30	280	-42.4	52	30	289	-50.3	33	
11,000	28	224	-57.4	13	13	215	-48.0	50	20	217	-64.9	50	25	226	-55.2	52	28	226	-56.0	52	29	241	-49.9	52	29	231	-55.8	33	
12,000	26	191	-57.7	13	13	185	-47.6	50	19	185	-54.8	50	23	193	-58.1	50	28	193	-56.9	50	27	206	-56.8	50	29	197	-58.9	33	
13,000	23	163	-58.2	11	11	159	-46.7	50	18	158	-53.5	50	20	164	-59.1	50	27	165	-57.8	50	27	175	-62.9	50	29	168	-60.7	33	
14,000	23	138	-59.3	9	9	137	-46.6	50	16	136	-52.7	50	18	140	-59.9	50	27	140	-58.5	50	27	148	-67.2	50	29	143	-62.5	33	
15,000	23	118	-60.7	7	7	118	-47.0	50	14	116	-51.9	50	17	119	-61.0	50	27	120	-59.6	50	27	125	-72.4	50	28	122	-64.5	33	
16,000	22	100	-61.4	13	13	99	-52.2	50	14	101	-62.1	50	26	102	-60.7	50	25	106	-75.4	50	27	103	-66.4	50	28	100	-63.3	33	
17,000	18	85	-61.6	10	10	85	-52.2	50	8	85	-62.8	50	22	87	-61.1	50	23	89	-74.5	50	23	88	-66.3	50	28	86	-63.3	33	
18,000	12	72	-61.3	6	6	73	-52.8	50	—	—	—	—	22	74	-60.6	50	20	76	-70.2	50	18	74	-65.6	50	28	72	-65.0	33	
19,000	—	—	—	—	—	—	—	—	—	—	—	—	15	63	-60.3	50	16	63	-64.8	50	10	63	-65.0	50	28	63	-65.0	33	
20,000	—	—	—	—	—	—	—	—	—	—	—	—	6	53	-60.4	50	11	54	-60.9	50	6	46	-59.3	50	28	46	-59.3	33	
21,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Altitude (meters) m. s. l.	Stations with elevations in meters above sea level																											
	Nome, Alaska (14 m.)				Norfolk, Va. <sup>1</sup> (10 m.)				Oakland, Calif. (2 m.)				Oklahoma City, Okla. (391 m.)				Omaha, Nebr. (301 m.)				Pearl Harbor, T. H. (6 m.) <sup>1</sup>							
	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity				
Surface	31	1,002	-11.9	78	20	1,022	5.7	74	31	1,014	10.4	81	31	973	3.2	87	31	983	-1.7	83	31	1,014	20.3	86	29	1,017	13.6	80
500	31	941	-12.0	80	20	961	5.0	65	31	955	11.4	70	31	960	4.6	83	31	959	-1.2	80	31	958	19.9	79	29	961	12.9	77
1,000	31	881	-12.3	81	20	904	3.4	59	31	900	9.7	65	31	903	5.4	65	31	902	.7	68	31	904	17.2	81	29	906	11.7	71
1,500	31	825	-12.8	79	20	850	2.9	52	30	847	7.5	61	31	850	5.4	55	31	847	.4	64	31	853	15.1	73	29	853	9.7	66
2,000	31	773	-14.7	75	20	799	1.8	46	30	797	5.0	57	31	799	4.6	49	31	795	-.8	60	31	803	13.6	53	29	803	7.7	59
2,500	31	723	-17.2	73	20	751	-2.2	38	30	749	2.4	55	31	751	2.4	46	31	747	-3.1	58	31	757	12.8	50	29	756	5.3	54
3,000	31	676	-20.0	72	20	705	-2.8	33	30	704	-.7	53	31	706	-.2	45	31	701	-5.3	56	31	713	11.3	49	28	710	2.7	48
4,000	30	590	-26.3	67	20	621	-8.0	30	30	620	-7.0	62	31	622	-5.9	43	31	617	-10.4	57	31	632	6.4	13	27	627	-3.2	51
5,000	30	513	-32.8	63	16	545	-14.3	28	30	545	-14.0	50	31	547	-12.3	39	30	541	-16.6	58	31	559	1.3	10	23	552	-9.6	51
6,000	30	444	-39.5	61	—	—	—	—	30	477	-20.9	50	31	479	-19.9	37	30	473	-23.5	57	—	—	—	22	484	-16.5	54	
7,000	29	383	-46.0	60	—	—	—	—	30	415	-28.0	49	30	418	-27.4	38	30	411	-30.6	56	—	—	—	22	424	-23.6	54	
8,000	28	329	-51.6	59	—	—	—	—	30	361	-35.4	48	29															

TABLE 1.—Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during December 1940—Continued

Altitude (meters) m.s.l.	Stations with elevations in meters above sea level																											
	Phoenix, Ariz. (339 m.)				Portland, Maine (9 m.)				St. Thomas, V. I. <sup>1</sup> (8 m.)				San Diego, Calif. <sup>1</sup> (19 m.)				S. S. Marie, Mich. <sup>1</sup> (221 m.)				Seattle, Wash. <sup>1</sup> (27 m.)				Spokane, Wash. (598 m.)			
	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity
Surface	31	976	11.0	76	31	1,016	-5.2	82	29	1,012	14.5	82	29	990	15.7	58	31	985	-6.9	92	21	954	5.9	75	15	933	2.9	88
500	31	958	14.0	87	31	956	-2.3	86	31	950	13.5	49	31	986	-8.2	90	31	897	3.6	72	15	839	1.6	84				
1,000	31	903	13.3	56	31	898	-2.8	79	31	902	13.5	49	31	840	-8.3	82	31	843	.8	71	14	839	1.6	84				
1,500	31	850	10.6	51	31	843	-3.4	79	31	849	10.6	45	30	787	-9.0	76	31	792	-1.8	68	14	788	-1.6	86				
2,000	31	800	7.7	49	31	791	-4.7	77	31	800	7.8	42	30	738	-10.5	73	31	743	-4.7	63	14	789	-4.6	88				
2,500	31	753	4.9	47	31	742	-6.2	74	31	752	5.0	40	30	691	-12.4	71	31	697	-7.5	59	14	694	-7.7	86				
3,000	30	709	2.3	45	31	696	-8.4	72	31	707	2.3	39	30	605	-17.4	70	30	612	-13.3	57	12	609	-13.1	77				
4,000	30	625	-4.0	41	31	611	-13.5	70	31	624	-4.1	44	30	529	-23.8	67	30	536	-19.8	55	11	533	-19.9	72				
5,000	30	550	-11.0	39	31	535	-19.1	69	31	549	-11.0	52	30	481	-18.0	55	29	480	-30.5	65	30	467	-26.9	69				
6,000	30	482	-18.2	38	31	467	-25.8	68	31	481	-18.0	55	29	399	-37.3	64	30	406	-34.2	61	8	404	-34.5	66				
7,000	30	420	-25.2	38	31	406	-33.0	68	31	421	-25.3	59	28	366	-32.3	37	31	344	-43.8	30	30	352	-41.6	37				
8,000	30	368	-32.6	38	30	351	-40.3	37	29	316	-39.5	37	27	273	-46.1	25	25	254	-55.8	30	30	303	-47.9	8				
9,000	28	317	-40.1	29	303	-47.2	37	27	316	-39.5	37	26	296	-50.0	30	30	298	-50.6	27	27	301	-49.1	8					
10,000	26	273	-46.7	28	260	-52.7	27	27	316	-46.1	25	26	281	-56.1	22	22	285	-56.1	27	27	258	-54.1	27					
11,000	24	234	-52.4	27	223	-55.7	27	24	234	-52.3	23	23	217	-56.9	22	22	223	-55.8	27	27	221	-54.9	27					
12,000	22	200	-56.4	24	190	-56.1	22	22	200	-55.8	22	22	185	-56.1	29	29	191	-55.8	8	8	189	-54.9	8					
13,000	20	171	-59.0	22	163	-58.3	16	171	59.2	21	21	158	-56.0	28	28	163	-54.7	8	8	161	-54.2	8						
14,000	20	145	-62.6	21	139	-57.6	15	146	62.3	20	20	135	-57.0	27	27	139	-54.9	8	8	138	-55.0	8						
15,000	20	122	-65.9	20	119	-59.0	11	124	65.7	20	20	116	-58.3	27	27	119	-55.6	7	7	118	-56.3	7						
16,000	18	104	-68.9	17	101	-59.6	9	105	67.9	15	15	99	-58.6	25	25	102	-56.3	7	7	101	-57.5	7						
17,000	13	88	-68.3	15	87	-60.6	6	89	69.7	10	10	84	-60.0	21	21	87	-56.7	13	13	74	-56.8	13						
18,000	10	74	-66.0	13	74	-60.9	6	72	-61.1	6	6	72	-61.1	13	13	62	-56.8	9	9	62	-56.8	9						
19,000	9	62	-63.9	8	63	-61.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
19,000	9	62	-63.9	8	63	-61.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Altitude (meters) m.s.l.	Stations with elevations in meters above sea level																													
	Swan Island, West Indies (10 m.)				Washington, D. C. <sup>1</sup> (7 m.)				October 1940 Barrow, Alaska (6 m.)				November 1940 Barrow, Alaska (6 m.)				November 1940 Bethel, Alaska (7 m.)				November 1940 Atlantic Station No. 1 <sup>3</sup> (3 m.)				November 1940 Atlantic Station No. 2 <sup>4</sup> (3 m.)					
	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity	Number of ob- servations	Pressure	Temperature	Relative hu- midity		
Surface	31	1,012	25.6	80	30	1,019	4.0	78	30	1,012	-4.2	92	30	1,014	-11.9	86	28	1,008	-4.4	90	22	1,020	17.4	70	18	1,021	17.1	73		
500	31	957	22.8	82	30	960	3.8	75	30	950	-6.8	91	30	951	-9.2	70	28	947	-2.9	87	22	961	12.8	76	18	962	13.0	76		
1,000	31	904	20.0	82	30	903	3.2	72	30	891	-9.2	91	30	891	-9.3	66	28	889	-4.7	86	22	906	8.8	81	18	907	9.2	78		
1,500	31	853	17.1	79	30	849	2.8	67	30	835	-10.5	84	30	835	-11.2	66	28	834	-7.0	79	22	852	5.5	80	18	853	5.4	80		
2,000	31	804	14.6	73	30	797	1.5	62	30	782	-12.0	76	30	782	-13.2	59	28	782	-3.7	66	22	802	3.4	76	18	803	4.3	70		
2,500	31	758	12.5	63	30	749	-1.0	59	30	732	-14.0	71	30	732	-15.7	55	27	732	-11.4	62	21	754	2.2	67	18	755	2.4	55		
3,000	31	714	9.8	57	30	703	-3.1	54	30	685	-16.6	69	30	685	-18.4	53	27	686	-14.4	62	20	708	0	59	16	709	.4	48		
4,000	30	632	4.7	43	30	619	-8.6	53	29	599	-22.3	65	30	598	-24.4	51	27	600	-20.9	61	19	624	-4.9	53	14	625	-5.3	43		
5,000	30	559	-1.1	35	29	543	-14.5	52	29	522	-29.0	63	30	520	-30.4	50	27	523	-27.8	60	11	549	-10.7	47	13	550	-10.9	39		
6,000	30	492	-7.7	36	28	475	-21.2	55	29	453	-36.2	60	30	451	-37.3	48	26	454	-34.7	62	9	481	-18.0	44	11	481	-18.2	40		
7,000	30	432	-14.2	34	28	414	-27.8	55	29	391	-43.2	55	29	390	-44.0	57	26	393	-41.7	62	7	420	-24.4	40	10	419	-26.2	41		
8,000	30	378	-20.8	35	16	360	-34.1	53	27	336	-49.7	57	29	335	-50.4	57	25	338	-47.5	62	7	344	-33.4	40	10	364	-33.4	40		
9,000	30	329	-28.3	34	16	311	-41.2	51	26	288	-54.1	59	29	287	-55.0	59	25	290	-51.2	62	7	314	-41.2	40	6	269	-48.0	40		
10,000	30	286	-36.3	31	14	270	-47.8	51	26	247	-53.8	59	27	245	-56.3	59	25	249	-54.0	62	7	314	-41.							

TABLE 2.—Free-air resultant winds based on pilot balloon observations made near 5 p. m. (75th meridian time) during December 1940. Directions given in degrees from North ( $N=360^\circ$ ,  $E=90^\circ$ ,  $S=180^\circ$ ,  $W=270^\circ$ )—Velocities in meters per second

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)		Albuquerque, N. Mex. (1,630 m.)		Atlanta, Ga. (299 m.)		Billings, Mont. (1,095 m.)		Bismarck, N. Dak. (512 m.)		Boise, Idaho (870 m.)		Brownsville, Tex. (7 m.)		Buffalo, N. Y. (220 m.)		Burlington Vt. (132 m.)		Charleston, S.C. (18 m.)		Chicago, Ill. (192 m.)		Cincinnati, Ohio (157 m.)		Denver, Colo. (1,627 m.)																
	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity													
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity											
Surface	27	236	1.6	31	340	1.1	27	324	0.6	30	252	4.6	27	291	1.9	31	125	1.4	26	136	0.8	28	251	2.8	27	176	1.8	26	192	0.7	23	265	1.8	30	244	1.1	31	352	0.9		
500																																									
1,000	26	254	2.0																																						
1,500	25	268	2.9																																						
2,000	24	267	4.8	31	295	7.3	22	271	4.8	30	271	7.8	21	282	9.1	31	169	2.9	16	281	2.1	18	259	10.3	13	291	9.6	25	238	3.9	15	249	8.3	24	229	5.9					
2,500	23	273	6.7	29	282	4.1	17	279	6.8	30	285	8.6	21	287	10.6	30	249	6.0	10	258	4.8	14	272	13.5	11	299	16.8	21	254	5.7	11	273	15.1	16	260	11.6	29	284	3.7		
3,000	23	277	7.9	27	293	6.6	15	283	9.1	28	288	9.3	20	279	10.2	28	262	7.1	17	283	10.9	22	271	8.7	11	277	15.9	11	255	9.4	11	275	17.2	12	267	14.2	29	295	5.4		
4,000	22	288	10.4	23	294	9.2	15	274	11.5	25	285	12.1	17	283	10.9	22	288	11.7	18	288	10.8	11	277	15.9	17	257	11.4	11	260	10.6	29	295	10.6								
5,000	21	292	10.5	21	286	9.5	15	280	13.9	22	287	15.2	16	298	11.7	21	288	10.8	13	295	10.1	19	295	15.9	13	277	15.1	16	260	11.6	29	295	13.3								
6,000	19	294	11.9	20	296	12.2	12	271	14.0	19	303	15.8	14	301	14.2	15	295	10.1	12	295	15.9	14	295	15.9	12	277	15.1	16	260	11.6	29	295	15.0								
8,000	14	308	13.2	18	313	14.9	10	271	19.6	12	323	12.5	11	291	9.6	12	295	15.9	11	295	15.9	10	276	15.9	10	277	15.9	11	260	11.6	29	295	21.1								
10,000	11	306	13.1	16	292	18.2	5.5	10	289	21.2	12	295	15.9	11	295	15.9	10	276	15.9	10	276	15.9	10	276	15.9	10	277	15.9	11	260	11.6	29	295	21.4							
12,000	10	304	13.9	13	289	21.2	12	295	15.9	11	295	15.9	10	276	15.9	10	276	15.9	10	276	15.9	10	276	15.9	10	277	15.9	11	260	11.6	29	295	21.4								

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)		Ely, Nev. (1,910 m.)		Grand Junction, Colo. (1,413 m.)		Greensboro, N. C. (271 m.)		Havre, Mont. (766 m.)		Jacksonville, Fla. (14 m.)		Las Vegas, Nev. (570 m.)		Little Rock, Ark. (79 m.)		Medford, Oreg. (410 m.)		Miami, Fla. (10 m.)		Minneapolis, Minn. (261 m.)		Mobile, Ala. (10 m.)		Nashville, Tenn. (194 m.)														
	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity	Observations		Direction	Velocity											
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity									
Surface	31	261	2.1	31	167	2.0	26	250	0.2	25	266	1.1	31	258	1.8	26	71	1.2	31	74	1.9	29	99	0.2	22	128	2.6	30	87	1.5	28	264	1.4	30	60	1.4	26	198	1.2
500																																							
1,000																																							
1,500	31	249	2.5				26	276	.1	25	249	3.7	31	253	5.7	24	188	3.5	31	62	2.7	26	255	2.9	21	160	4.6	30	95	2.4	28	263	2.9	30	105	.9	22	237	4.2
2,000	31	269	3.7	31	169	2.4	26	202	.6	6	23	270	7.7	31	266	10.7	21	244	5.6	6	28	232	4.9	21	184	5.0	28	172	1.5	19	280	7.2	22	272	2.2	20	259	6.2	
2,500	30	276	5.7	30	206	2.9	24	229	2.3	23	272	9.0	29	274	10.2	21	251	6.8	24	248	2.0	20	295	7.4	14	234	7.6	28	215	3.3	15	282	12.3	20	291	6.0	19	266	10.2
3,000	29	272	6.5	28	245	2.9	22	243	4.9	23	275	11.1	29	271	11.0	20	262	7.6	23	283	8.9	18	292	10.3	10	294	3.5	27	222	4.8	11	281	12.1	18	288	8.2	18	269	11.9
4,000	26	275	7.5	22	279	6.9	20	275	7.7	20	268	14.2	22	274	9.4	16	269	8.9	23	276	6.9	17	287	14.2	14	261	6.0	17	266	10.3	15	285	13.4						
5,000	25	267	9.5	21	281	9.8	18	284	11.3	16	270	18.2	21	270	8.9	17	257	12.8	21	278	8.8	12	286	13.5	17	243	8.1	11	269	9.9	11	294	17.0						
6,000	22	285	10.1	21	281	10.7	15	294	15.5	15	268	19.0	16	280	8.1	17	263	14.0	19	272	10.6	10	276	16.3	10	276	15.5	10	276	15.5	10	277	15.5						
8,000	13	295	17.9				12	272	23.8	10	319	7.9	12	272	16.4	15	285	19.2	10	276	16.5	10	276	16.3	10	276	15.5	10	277	15.5									
10,000	11	274	24.9				10	276	31.7							10	276	31.7																					
12,000	10	272	16.3																																				

See footnotes at end of table.

TABLE 3.—Maximum free-air wind velocities (m. p. s.), for different sections of the United States, based on pilot-balloon observations during December 1940

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station
Northeast <sup>1</sup>	44.2	WSW	1,090	16	Toledo, Ohio	49.2	W	4,970	12	Caribou, Maine	70.4	WNW	5,870	18	Caribou, Maine.
East-Central <sup>2</sup>	43.8	SW	2,310	16	Elkins, W. Va.	44.7	NW	5,000	7	Nashville, Tenn.	66.0	WSW	13,046	20	Greensboro, N. C.
Southeast <sup>3</sup>	30.1	ESE	1,190	24	Birmingham, Ala.	39.2	SSW	3,880	27	Miami, Fla.	56.0	WSW	11,900	31	Jacksonville, Fla.
North-Central <sup>4</sup>	47.5	NW	2,150	6	Rapid City, S. Dak.	43.2	W	4,660	9	Huron, S. Dak.	67.4	NW	8,180	26	Duluth, Minn.
Central <sup>5</sup>	44.2	WSW	1,470	5	Des Moines, Iowa	50.4	NW	4,300	29	Wichita, Kans.	64.8	NW	9,020	28	Wichita, Kans.
South-Central <sup>6</sup>	37.4	N	1,710	26	Abilene, Tex.	65.8	NNW	4,390	27	Abilene, Tex.	66.0	NW	21,310	5	Abilene, Tex.
Northwest <sup>7</sup>	38.7	E	260	16	Tatoosh Island, Wash.	55.8	W	3,200	5	Havre, Mont.	67.0	W	13,870	21	Billings, Mont.
West-Central <sup>8</sup>	40.8	WNW	2,480	6	Cheyenne, Wyo.	48.8	W	3,280	5	Sheridan, Wyo.	92.2	NW	8,910	28	Casper, Wyo.
Southwest <sup>9</sup>	57.5	NW	2,278	25	Roswell, N. Mex.	47.0	S	3,810	28	Sandberg, Calif.	78.9	WNW	8,760	25	Las Vegas, Nev.

<sup>1</sup> Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and Northern Ohio.

<sup>2</sup> Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, Eastern Tennessee, and North Carolina.  
<sup>3</sup> South Carolina, Georgia, Florida, and Alabama.

<sup>3</sup> South Carolina, Georgia, Florida, and Alabama.  
<sup>4</sup> Michigan, Wisconsin, Minnesota, North Dakota

<sup>4</sup> Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.  
<sup>5</sup> Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.

- Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.

TABLE 4.—Mean altitudes and temperatures of significant points identifiable on the map.

<sup>6</sup> Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except extreme West Texas) and Western Tennessee.  
<sup>7</sup> Montana, Idaho, Washington, and Oregon.

<sup>7</sup> Montana, Idaho, Washington, and Oregon.  
<sup>8</sup> Wyoming, Colorado, Utah, Northern Nevada.

<sup>1</sup> Wyoming, Colorado, Utah, Northern Nevada, and Northern California.  
<sup>2</sup> Southern California, Southern Nevada, Arizona, New Mexico, and ex-

**Southern California, Southern Nevada, Arizona, New Mexico, and extreme west Texas.**

TABLE 4.—Mean altitudes and temperatures of significant points identifiable as tropopause during December 1940, classified according to the potential temperatures ( $10^{\circ}$  intervals between  $290^{\circ}$  and  $409^{\circ}$  A.) with which they are identified (based on radiosonde observations)

Stations.....	Anchorage, Alaska			Barrow, Alaska			Bethel, Alaska			Bismarck, N. Dak.			Brownsville, Tex.			Charleston, S. C.			Denver, Colo.			El Paso, Tex.			
	Potential tempera- tures °A.	Number of cases	Mean altitude (km.) m. s.l.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera- ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera- ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera- ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera- ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera- ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera- ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera- ture °C.	
290-299.....	13	6.4	-43.4	20	6.4	-45.7	8	7.3	-53.1	4	6.8	-43.5	1	6.7	-31.3	1	6.4	-27.0							
300-309.....	26	7.7	-48.9	19	6.9	-51.8	15	8.4	-55.5	16	7.5	-41.9	2	7.1	-28.0	3	7.5	-32.3	24	9.1	-49.9	14	8.5	-41.0	
310-319.....	19	9.4	-57.3	18	9.6	-59.3	6	9.0	-57.2	29	10.4	-56.5	15	9.1	-38.7	17	9.9	-48.2	25	10.5	-55.8	20	10.3	-52.8	
320-329.....	9	10.5	-60.8	1	10.5	-62.0	3	9.7	-55.7	5	10.7	-54.8	16	11.0	-51.4	21	11.4	-55.1	7	11.6	-60.7	10	11.4	-57.0	
330-339.....	1	12.2	-67.0	1	10.6	-55.0				4	11.2	-53.0	7	13.1	-65.3	16	12.8	-63.2	2	12.0	-58.0	6	12.5	-61.7	
340-349.....				1	11.0	-51.0				4	12.2	-56.8	4	13.8	-65.2	5	13.6	-65.4	4	12.7	-60.2	7	13.8	-67.4	
350-359.....							5	12.7	-55.4	7	15.0	-71.6	5	14.8	-70.2	2	14.0	-62.0	4	14.6	-68.8				
360-369.....				1	13.0	-54.0	1	13.3	-56.0				10	15.9	-71.3	3	15.4	-69.3	5	14.4	-62.2	6	15.5	-72.8	
370-379.....										3	14.1	-55.0	4	16.2	-73.2	2	15.6	-68.0	2	15.6	-70.0	6	15.8	-71.0	
380-389.....										2	14.6	-56.0	7	16.7	-72.9	9	16.0	-68.0				4	16.2	-70.2	
390-399.....	1	13.7	-53.0	2	14.2	-55.5				4	15.3	-56.5	3	16.8	-68.3	4	16.9	-69.8	2	16.2	-65.5	3	16.4	-67.7	
400-409.....	1	14.4	-50.0							10.1	-51.9		12.9	-58.9		12.5	-58.8		10.8	-54.9		12.1	-57.9		
Weighted means.....		8.6	-52.0		8.0	-52.4		8.4	-55.2																
Mean potential temperature °A. (weighted).....		312.0			309.6			305.4			328.8			353.3			349.1			331.6			344.4		
Number days with observations.....		29			23			16			31			26			29			28			27		

Stations	Ely, Nev.			Fairbanks, Alaska			Great Falls, Mont.			Joliet, Ill.			Ketchikan, Alaska			Lakehurst, N. J.			Medford, Oreg.		
Potential temperatures °A	Number of cases	Mean altitude (km.) m. s.l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean temperature °C.
290-299	1	7.9	-53.0	6	6.9	-50.0	3	7.3	-49.0	1	6.4	-39.0	3	5.8	-36.3	1	5.6	-32.0	1	5.6	-32.0
300-309	7	7.8	-46.1	17	8.3	-52.6	9	7.9	-46.9	5	8.2	-48.2	11	7.3	-43.9	4	7.2	-39.5	4	7.2	-39.5
310-319	13	8.3	-43.2	11	9.1	-54.6	15	9.7	-56.9	19	9.1	-49.6	19	9.4	-55.4	13	8.7	-45.2	13	8.6	-45.2
320-329	24	10.8	-57.2	1	9.4	-50.0	14	10.8	-59.4	25	10.5	-57.2	10	10.4	-58.8	15	10.8	-54.3	25	10.8	-58.2
330-339	12	11.7	-61.4				2	11.2	-59.0	8	11.4	-60.1	1	11.9	-67.0	12	11.5	-59.5	10	11.5	-59.1
340-349	2	12.6	-64.0	1	11.9	-61.0	2	11.9	-59.5	2	12.4	-65.0	1	12.4	-64.0	5	12.4	-62.2	3	12.7	-64.0
350-359	3	12.8	-60.0							1	13.1	-65.0									
360-369	1	14.5	-67.0													3	13.5	-60.7	5	13.5	-63.0
370-379	3	13.8	-59.3	3						2	13.0	-52.0	3	14.3	-63.7	1	13.3	-55.0	3	14.1	-62.3
380-389	6	15.4	-67.5				4	14.6	-61.2	3	15.1	-64.7	2	13.7	-47.5	1	16.2	-67.0	5	15.0	-64.2
390-399	10	15.4	-63.0							4	15.2	-60.2									
400-409	3	16.3	-65.7				3	15.7	-61.0	4	16.1	-64.2									
Weighted means		11.6	-56.8		8.4	-52.9		10.5	-56.0		11.0	-56.1		9.3	-52.4		10.5	-53.5		11.2	-56.3
Mean potential temperature °A (weighted)	341.1			307.1			328.7			335.0			318.5			330.1			336.7		
Number days with observations	30			18			26			30			21			26			28		

TABLE 4.—Mean altitudes and temperatures of significant points identifiable as tropopause during December 1940, classified according to the potential temperatures ( $10^{\circ}$  intervals between  $290^{\circ}$  and  $409^{\circ}$  A.) with which they are identified (based on radiosonde observations)—Continued

Stations	Miami, Fla.	Nashville, Tenn.	Nome, Alaska	Oakland, Calif.	Oklahoma City, Okla.	Omaha, Nebr.	Phoenix, Ariz.																
Potential tempera-tures °A.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera-ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera-ture °C.	Number of cases																
290-299				17	6.7	-46.7																	
300-309				14	8.3	-54.9																	
310-319	2	7.2	-26.5	8	9.2	-49.9	14	8.9	-56.0	5	7.1	-38.2	1	7.2	-35.0								
320-329	6	9.1	-39.2	28	10.2	-52.9	3	9.4	-53.3	22	10.4	-54.7	24	10.3	-54.9	21	8.9	-46.1	5	7.9	-39.2		
330-339	24	11.5	-58.0	12	11.6	-60.2	2	10.0	-50.0	13	11.4	-57.3	10	11.6	-59.0	7	11.0	-55.7	17	10.0	-48.4		
340-349	13	12.9	-63.5	12	12.4	-61.7		1	13.1	1	11.4	-51.0	4	13.6	-66.0	2	12.5	-61.8	13	11.3	-55.2		
350-359	10	14.0	-68.0	2	13.2	-63.0	1	11.4	-51.0	4	13.6	-66.0	4	13.4	-66.5	2	12.7	-58.0	3	12.5	-58.3		
360-369	12	15.3	-75.9	2	14.4	-65.5	1	12.4	-59.0	3	13.5	-61.7	1	14.3	-65.0	1	14.1	-65.0	6	14.5	-68.8		
370-379	3	15.8	-77.3	6	14.5	-66.0		2	17.7	5	15.0	-68.6	2	14.8	-68.5	6	15.5	-71.3					
380-389	7	16.4	-76.3	4	15.3	-67.5		4	15.3	5	15.6	-70.5	2	14.7	-60.5	4	15.9	-72.8					
390-399	3	16.6	-72.7	9	16.0	-68.1		6	15.7	2	16.2	-70.0	5	15.1	-59.2	2	16.6	-72.0					
400-409	4	17.2	-72.5	1	16.6	-72.0		5	16.2	2	16.1	-64.5	4	15.8	-61.5	2	17.0	-72.0					
Weighted means		13.3	-63.4		12.0	-68.9		8.2	-52.2		11.8	-56.7		11.6	-57.9		10.8	-53.1		12.1	-57.1		
Mean potential temperature °A (weighted)	352.2	344.1	308.1	343.2	338.3	336.7	345.1																
Number days with observations	28	29	26	29	24	26	24																

Stations	Portland, Maine	San Diego, Calif.	Sault Ste Marie, Mich.	Seattle, Wash.	Atlantic Station No. 1	Barrow, Alaska	Late report, November 1940															
Potential temperatures °A.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera-ture °C.	Number of cases	Mean altitude (km.) m. s.l.	Mean tempera-ture °C.	Number of cases															
290-299																						
300-309	3	6.1	-38.7																			
310-319	11	7.6	-43.5																			
320-329	21	8.8	-48.0	2	8.6	-42.0	9	6.9	-39.2	9	8.3	-51.3	1	7.6	-45.0	28	8.2	-52.6				
330-339	22	10.2	-54.7	10	10.2	-53.3	12	10.4	-58.0	20	10.4	-55.2	12	10.2	-53.1	18	9.4	-57.2				
340-349	10	11.4	-60.5	11	11.1	-55.7	1	10.9	-57.0	5	11.5	-59.8	10	11.7	-60.7	2	11.2	-59.5				
350-359	2	11.4	-55.0	3	12.1	-56.7	3	11.4	-56.0	1	12.0	-58.0	3	12.8	-65.7	2	11.2	-55.0				
360-369				1	12.3	-53.0				1	12.0	-57.0	3	12.8	-60.3	1	11.6	-55.0				
370-379	1	12.7	-58.0	2	14.1	-64.5				1	13.4	-57.0	1	14.8	-71.0	1	12.2	-54.0				
380-389	3	14.7	-65.0	1	14.6	-64.0	2	13.0	-53.5	1	13.4	-57.0	3	14.1	-61.7							
390-399	2	14.2	-57.5	1	15.5	-65.0	4	14.0	-57.8				3	15.4	-67.7							
400-409	3	15.3	-62.7							1	15.1	-62.0	5	16.0	-67.0							
Weighted means		10.0	-52.3		11.4	-55.7		9.8	-52.3		10.2	-54.4		12.0	-57.9	1	14.6	-53.0	9.0	-54.8		
Mean potential temperature °A (weighted)	327.2	337.8	325.7	325.5	343.9	312.4																
Number days with observations	26	20	23	30	17	29																

Information contained in footnotes to Table 1 are also applicable to Table 4.

#### AEROLOGICAL OBSERVATIONS FOR THE YEAR 1940

By EARL C. THOM

At the end of 1940, radiosonde observations were being made at 26 Weather Bureau stations and at 5 Navy stations, while 3 other Navy stations were using airplanes to record upper-air conditions. At the end of the previous year radiosonde observations were being made at 25 Weather Bureau stations, 3 Navy stations and 1 Army station, while 6 Navy stations were making airplane observations. Changes were made in the location of several Weather Bureau radiosonde stations in the United States and several new stations were established in Alaska during the latter months of the year. The stations at which upper air observations were made during each month of the year are shown in Table 4 which tabulates the number of observations made at the various stations.

Valuable upper air data were obtained during the 1940 hurricane season from radiosonde observations made at

San Juan, Puerto Rico as well as from special observations made at several of the regular radiosonde stations. Upper air data were also obtained in the ocean area between  $40^{\circ}$  to  $52^{\circ}$  N. latitude and  $47^{\circ}$  to  $55^{\circ}$  W. longitude from radiosonde observations made by United States Coast Guard Cutters while on ice patrol duty.

Radiosonde observations were begun in May as part of a regular weather reporting service established on board Coast Guard Cutters in the Atlantic Ocean in areas, termed Atlantic Stations No. 1 and No. 2. For the location of these stations the reader is referred to the footnote of table 4.

Monthly mean values of temperature, pressure, and relative humidity for all the standard levels of the free air have been published each month as Table 1 under Aerological Observations in the MONTHLY WEATHER REVIEW.

Table 1 for the year 1940, tabulates annual mean pressures, temperatures, and relative humidities for all stations for which such data were available during the entire